# Water Moat Mealworm Bioreactor for Waste Recycling


## Author-

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## Abstract-

In this study, an affordable and integrative research design has been devised by the WORLD INNOVATIVE RESEARCH ORGANIZATION™ for sustainable farming of insects and circular agriculture. This is a setup planning for future which involves a 40 square feet water moat around a concrete platform where a strong metal table and a plastic box having a netted cover to cultivate 1000 Tenebrio molitor mealworms are placed. Four concrete pillars in the water serve the purpose of maintaining biosecurity by preventing pests from entering, while a tin roof shade with soil and plants acts as thermal regulator. Vegetable waste is then provided as the raw material that will allow the mealworms to produce biomass with high protein levels and frass fertilizers from the organic waste. This type of closed system design will involve the application of insect biotechnology combined with rooftop gardening and water conservation in order to solve the problems related to food insecurity, waste management and lack of urban space. In future WIRO Mealworm Research Area represents an example of an approach to biotechnology and agriculture research that can be used in other colleges and research institutions. This project will also give practical experience in sustainable research to the interns of the Students Project regarding careers related to Biotechnology, Agriculture, Entomology, Engineering etc.


## Introduction-

The issues of food security, organic waste build-up and urban land scarcity have led to the necessity for sustainable and circular agriculture. Conventional farming systems consume many resources and produce waste. Insect technology can provide a solution; Tenebrio molitor mealworms are known for their capability to

convert waste into valuable biomass. They are already widely used in animal feed, pet food and as a soil additive. However, there is a lack of economical, biosecure mealworm cultivation technologies, particularly for student research.WORLD INNOVATIVE RESEARCH ORGANIZATION™ registration no UDYAM-WB-09-0064313 Organization Type- Others.

This can be filled in with the design of a research model by WORLD INNOVATIVE RESEARCH ORGANIZATION™ known as the "Mealworm Research Area," where the organization plans not only for the not presently ready setup but also for ready to use quickly. The research area is designed in such a way that it has a 40 sqft water moat surrounding a concrete island platform. This research area has a robust metal table set up on the platform containing a large plastic container covered with a net to rear 1000 mealworms. The water moat surrounded by four concrete pillars in water is an automatic barrier to ants and other pest invasions that provide biosecurity without the need for any chemical treatment. Over the rearing area, there is a large tin roof shade that protects the rearing area from rain and sunlight.

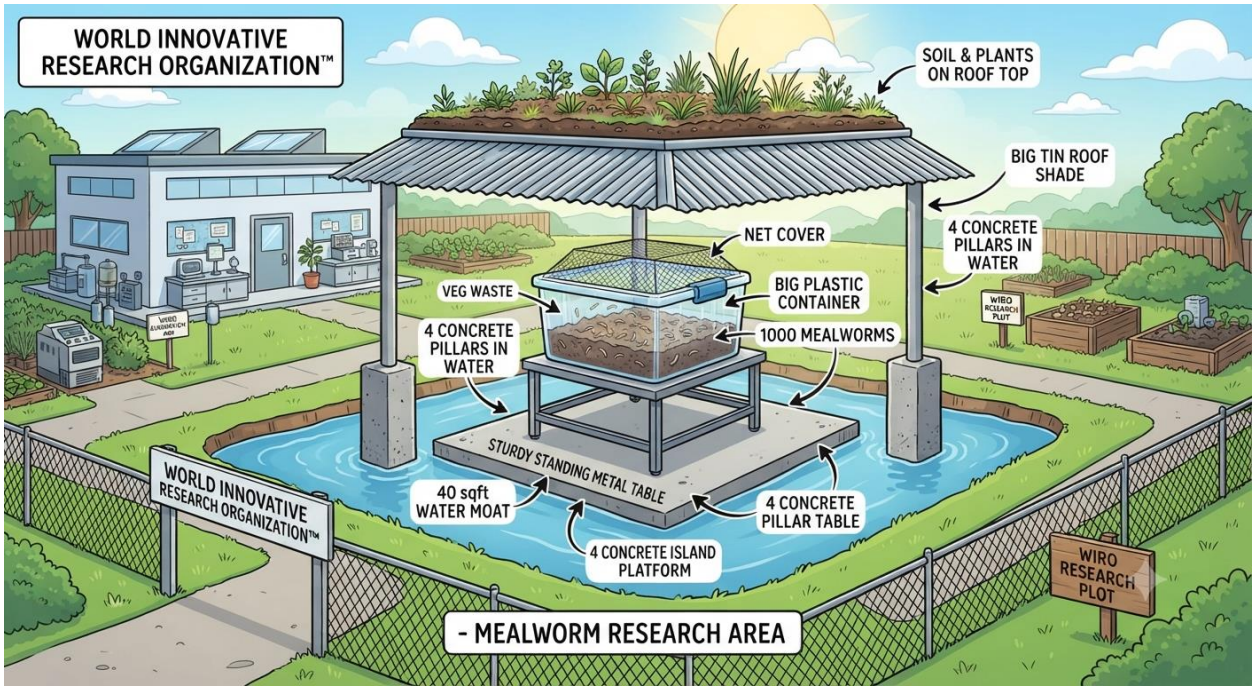
The three main elements that make up this system are insect rearing, organic waste management, and rooftop farming. Vegetable wastes are fed to the insects, completing the cycle from waste to biomass production. This model is cost-effective, replicable and appropriate for teaching students in biotechnology, agriculture and sustainable development.

Interns are being trained using this technology as a component of the WIRO Student Project, to acquire practical experience in sustainable research. This report explains the construction, functioning principle, and application areas of the WIRO water-moat mealworm bioreactor.

# Materials and Methods-

### 1. Site & Design-

The design-based planning was carried out at the Race Course Para, Jalpaiguri Ward No-10 Head Office of WORLD INNOVATIVE RESEARCH ORGANIZATION™. This was just an attempt in designing that has not been actually implemented. But for doing this quickly a rectangle area of 40 sqft was demarcated and dug to build a moat of water which is 1 ft wide and 0.5 ft deep continuously. In the middle a platform of size 4x4 ft of concrete was built. There were four pillars of height 2 ft each placed inside the moat for supporting the platform.




**2. Set up of Rearing Unit-**

A strong metallic table of size 3x2 ft was erected on the concrete platform. There was an enormous plastic box of capacity 50 L, with perforated lid and net cover on the table for the rearing of  Tenebrio molitor mealworms. Initially, 1000 larvae were stocked. The net cover helped in the maintenance of good ventilation and prevented escape and entry of pests. Above the system, there was a huge tin roof shade of size 6x6 ft at a height of 7 ft from the ground to give protection against rain, direct sunlight, and birds.

**3. Feeding and Maintenance-**

Organic vegetables waste from the house was cut into pieces of 2-3 cm and fed to the larvae freely. The moat was filled with water and was refilled once in a week to keep the pest screen effective. The temperature and humidity in the container was recorded on daily basis through a digital thermo hygrometer. The rearing unit was cleaned every fortnight and frass collected for fertilizing the rooftop plants.

**4. Training and Data Collection-**

The total interns of the WIRO of Student Project participated in regular observations and recordings of various parameters including larval growth rate, survival percentage, waste consumption rate and frass production for 60 days.

This cost-effective and sustainable system can be replicated for education on biotechnology in colleges and other research institutions.

**(It's AI Generated Design for future work)**

## Results and Discussion-

The proposed WIRO Water Moat Mealworm Bioreactor system is an affordable and biologically secure dual-use system that can be employed for insect rearing as well as urban agriculture. It features a 40 sqft water moat in addition to a concrete island platform, metallic table and 50-liter rearing box used to house 1000 Tenebrio molitor larvae. The system incorporates the use of a water moat as well as 4 concrete pillars in order to avoid entry of ants/pests into the facility without using pesticides.

The large tin roof shade will be able to control the temperature as well as protect the culture from rainfall and any predator attack and the soil covering on the roof top allows for vegetables to grow. This two-fold utilization of vertical space will help in achieving the idea of a circular economy.

Depending on the project, the mealworms have the ability to convert 1 kg of vegetable waste into ~200g biomass and ~600g frass within 60 days. The WIRO

system would be capable of doing the same but would also produce vegetables on the rooftops.

For Interns of WIRO Student Project, the design serves the purpose of providing practical knowledge about biotechnology and waste management as well as sustainable agriculture. This model can be replicated by colleges and research institutions as well.

## Conclusion-

The WIRO Water Moat Mealworm Bioreactor system is an inexpensive, safe and sustainable system for waste recycling, insect farming and urban rooftop agriculture. It serves as a training tool for the WIRO Student interns.

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